IEEE 802.1Qbp:
Hash Proposal

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V 0.2
Agenda

• Overview

• Hash Functions Evaluated

• Review Results

• Observations

• New Functions Evaluated -1
Goals

• Identify hashing strategies that provide good flow distribution for multi-hop networks in a deterministic manner
Evaluating Load Balancing Performance

Approach

- Transmit flows from Edge source device (root node) and measure flow distribution across spine devices.
- Use an N-ary tree with a degree of 4 and a depth of 3 hops.

Measure

- Standard deviation of flows received at the spine devices.
Path Selection Data Flow

Per Hop Node Seed(s)

Extract Packet Fields

Hash Function

Hash Value modulo (# of paths)

Entropy, BMAC-SA, BMAC-DA

BROADCOM

Connecting everything
Hash Input Fields

- Entropy (16-bit)
- Per-hop Node Seed
- BCMAC SA
- BCMAC DA
Agenda

• Overview

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• New Functions Evaluated -1
• Baseline Hash Function
  XOR of the following attributes:
  • 16-bit Entropy Value
  • 16-bit Node Seed (unique per hop)
Hash Functions Evaluated – 2

• Baseline + BMAC SA + BMAC DA Hash Function
  – XOR of the following attributes:
    • 16-bit Entropy Value
    • BMAC SA
    • BMAC DA
    • 16-bit Node Seed (unique per hop)
Hash Functions Evaluated – 3

• **CRC16-CCITT**
  
  – CRC based on the following packet attributes:
    
    • 16-bit Entropy Value
    • BMAC SA
    • BMAC DA
    • 16-bit Node Seed (unique per hop)

  – CRC Polynomial: \( x^{16} + x^{12} + x^5 + 1 \)
Hash Functions Evaluated – 4

- **Baseline + Node Seed Shift**
  - XOR of the following attributes:
    - 16-bit Entropy value shifted (circular) by the amount in Node Seed[3:0]
    - BMAC SA shifted (circular) by the amount in Node Seed[7:4]
    - BMAC DA shifted (circular) by the amount in Node Seed[11:8]
    - Node Seed[31:16]
  - Node Seed is unique per hop
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Test Setup

• **Topology**: N-ary Tree
  – Degree: 4
  – Depth: 3 hops
  – Spine devices: 64

• **Simulation Constraints**
  – 19,200 flows originating at edge source device
    • (300 flows) x (# of spine devices)
  – BMAC SA/DA limited to 64 unique values
Simulation Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Average Standard Deviation (20 Iterations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>1,162</td>
</tr>
<tr>
<td>Baseline + BMAC SA + BMAC DA</td>
<td>1,162</td>
</tr>
<tr>
<td>CRC16-CCITT</td>
<td>1,162</td>
</tr>
<tr>
<td>Baseline with Node Seed Shift</td>
<td>124</td>
</tr>
</tbody>
</table>
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• Overview

• Hash Functions Evaluated

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  • Observations

• New Functions Evaluated -1
Observations and Next Steps

• Observations
  – XOR with circular shift based on a per-node seed provided good performance with low implementation cost

• Next Steps
  – Look at other functions
    • FNV
    • Ideal
Agenda

• Overview

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• New Functions Evaluated -1
New Hash Functions Evaluated

- **Case A - Ideal**
  - Random value generated for every flow at every node
  - *Next Hop Selection*: Random Value mod (# of Next Hops)
Hash Functions Evaluated

- **Case B - FNV**
  - FNV-16
    - FNV32 with 32-bit output folded using XOR of:
      - Hash Value[15:0]
      - Hash Value[31:16]
    - **Offset-basis**: 0x811c9dc5
    - **Octets of Data**:
      - Entropy (2 octets)
      - Node Seed (2 octets)
      - BMAC SA (2 octets)
      - BMAC DA (2 octets)
Simulation Results

<table>
<thead>
<tr>
<th>Case</th>
<th>Average Standard Deviation (20 iterations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case A: Ideal</td>
<td>17.33</td>
</tr>
<tr>
<td>Case B: FNV</td>
<td>29.72</td>
</tr>
</tbody>
</table>
New function Observations and Next Steps

• Observations
  - FNV shows very good behavior and is approaching very close to ideal

• Next Steps
Thank You